

REMARKS

The examiner's action dated May 6, 2011, has been received, and its contents carefully noted.

Claim 1 has been amended to more clearly define the contribution of the invention over the prior art and the rejection presented in section 8 of the action is traversed for the reason that the present claims, and particularly claim 1, define subject matter that is not suggested by any combination of the applied references.

Claims 1, 4, 5, 7, 8, 10, 11, 13-20, 24, 27-35 and 41-46 are rejected under 35 U.S.C. 103(a) as being unpatentable over newly cited U.S. 5,572,052 (hereinafter Kashiwara) "as evidenced by" U.S. 5,504,330 (Summerfelt).

It must be noted that the meaning of the phrase "as evidenced by" is not readily apparent and that the explanation of the rejection does not include any indication of the manner in which the references are being combined, or any reasoning supporting such a combination.

The pending claims clearly distinguish over the applied references at least by the recitation in claim 1 of a "quasi-amorphous pyroelectric compound being a product of application of a mechanical strain to a substantially amorphous compound".

Appln. No. 10/560,107
Amdt. dated November 3, 2011
Reply to Office action of May 6, 2011

The Examiner argues that Kashihara discloses a step of sputtering a material onto a silicon substrate and then annealing at a temperature of 500-700 °C **to form a perovskite type crystal structure film that includes the amorphous morphology**, e.g. an amorphous layer (see column 11, line 25-49). The Examiner refers to column 11, line 43-49 of Kashihara, which states: "*It has been reported that by forming a SrTiO₃ film by sputtering on a silicon substrate, a crystallized SrTiO₃ layer was formed following a SiO₂ layer and an amorphous SrTiO₃ layer* (Sakuma et al., Applied Phys. Lett. 57, (23), 3 Dec. 1990, pp. 2431-2433)."

In this connection, applicant has reviewed Sakuma et al.'s article (copy attached), and would like to draw the Examiner's attention to the following:

The related article, Sakuma et al., Applied Phys. Lett. 57, (23), 3 Dec. 1990, pp. 2431-2433, discloses for example at page 2431 third paragraph that "*A thin layer SiO₂ (~ 3 nm in thickness) was formed at the SrTiO₃-Si substrate interface. An amorphous layer was observed in the SrTiO₃ layer near the SiO₂ layer. **Although this layer was crystallized after 600°C annealing, ...***"

Therefore, it is clear that the examiner's statement that annealing at a temperature of 500-700 °C used in the

above references forms a perovskite type crystal structure film that includes the amorphous morphology is wrong.

Moreover, the Examiner has no right to make such a statement because it is not supported by the reference. The reference clearly discloses that further annealing will result in crystallization of an initially amorphous film. Therefore, the interpretation by the Examiner that Kashihara discloses a quasi-amorphous pyroelectric compound being a product of application of a mechanical strain to a substantially amorphous compound is erroneous.

Further, Kashihara describes (see column 6 lines 67- column 7 lines 9) that "Titanate or zirconate **forms and holds a perovskite type crystal structure** on a material constituting an electrode in an easier manner than PZT and PLZT. According to the present invention, because a PZT or PLZT is provided on an electrode via a sub-insulating layer consisting essentially of titanate or zirconate, a main insulating layer having a perovskite type crystal structure and exhibiting high dielectric constant can be formed. **PZT or PLZT can provide a perovskite type crystal structure** of small and uniform crystal grain size on a sub-insulating film of titanate thereof." As also described in Kashihara in column 7 lines 32- column 7 lines 35: "The sub-insulating layer can be formed by a liquid phase method such as sol-gel method, PVD such as **sputtering**,

or by CVD method such as MOCVD." **Therefore a perovskite type crystal material forms the sub-insulating layer.**

The "step of gradient heating", as referred to by the Examiner, will lead to a crystal layer and not to an amorphous layer. No specific process of restriction of volume expansion is applied to the layer to prevent nucleation. The Examiner refers to page 8 lines 13-26 of the present specification and argues that *"the step of heating the sputtered Si substrate at 500-700 °C is a mechanical strain that would prevent crystallization of the amorphous compound and form a macroscopic dipole moment"*.

Applicant disagrees with the above interpretation. The mechanical strain has to be a **steep temperature gradient** and not an annealing. Annealing is typically characterized by a specific temperature, while the invention needs varying temperature along the film. **The temperature gradient has to be carefully controlled and to be such as to prevent crystallization of the amorphous compound, thereby obtaining highly stressed amorphous films (as described in page 8 lines 14-17). As described in page 9, lines 14-20, of the present specification, the strain gradient has two components: in-plane (along the temperature gradient), and out-of-plane (a result of the clamping caused by the cold part of the film) [16]. The latter component is responsible for the out-of-plane**

orientation of the crystal motifs in the films. Thus, if the crystal motifs are polar, their partial orientation creates a sense of polarity in a quasi-amorphous film as a whole. Once formed, the motifs cannot change their orientation due to the large in-plane compressive stress [18,19].

In this connection, it should be understood that an annealing process is a heating process under isothermal conditions and not under a temperature gradient as illustrated for example in Fig. 3B of the present application. An annealing process cannot have an in plane component since it has a uniform temperature distribution.

As has been explained in response to each office action, the present invention is aimed at providing a novel pyroelectric compound by subjecting an amorphous compound to a mechanical strain where the mechanical strain does not promote the formation of crystallites within the quasi-amorphous compound. Kashiwara as well as Summerfelt do not disclose any formation of amorphous or quasi-amorphous compounds or structures, but rather disclose formation of crystalline structures.

Since the remaining pending claims depend, directly or indirectly, from claim 1, and therefore incorporate the limitations of claim 1, the remaining claims are patentable over the prior art.

